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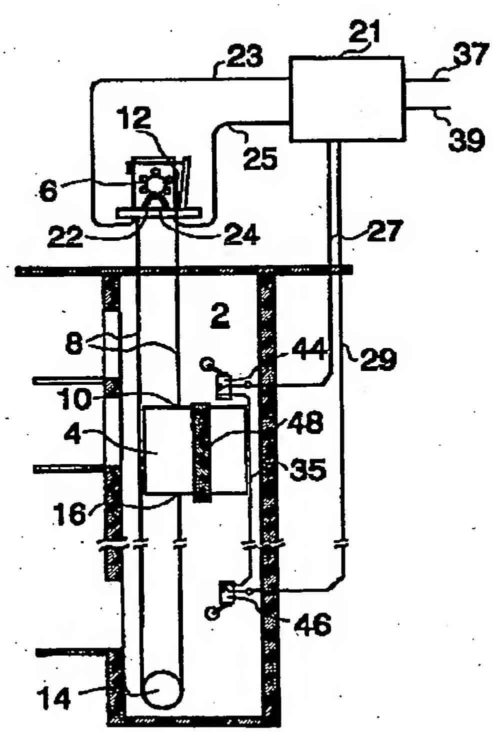
(54) Title: PROCEDURE AND APPARATUS FOR INDICATING ELEVATOR SPEED

(57) Abstract

The invention relates to a procedure and an apparatus for the indication of overspeed when an elevator car (4) reaches the limit switch (44, 46) for a terminal floor. The speed is measured from an overspeed governor (6) by means of an inductive proximity switch (22, 24). An internal oscillator is used to measure the length of the signal obtained from the proximity switch (22, 24) and if the signal length is below a limit value when the elevator is within the area of a terminal limit switch (44, 46), the safety circuit is opened.



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PROCEDURE AND APPARATUS FOR INDICATING ELEVATOR SPEED

The present invention relates to a procedure for indicating speed of a traction sheave elevator wherein the elevator car is suspended by suspension ropes as defined in the preamble of claim 1. The invention also relates to an apparatus as defined in the preamble of claim 6.

To drive an elevator to the level of a floor and to stop it safely, reliable and accurate measurement of the speed of the elevator is necessary. When the elevator is approaching a terminal floor, i.e. the topmost or bottommost floor, its speed must be below a certain allowed limit speed value when the elevator reaches a so-called terminal limit switch. If at this stage the elevator speed is above the allowed value, the safety circuit of the elevator is opened and the elevator is stopped via emergency braking. This emergency terminal slowdown and stopping (ETS) is a safety precaution designed to prevent the elevator from running onto the buffers on the shaft bottom or to the shaft top at an excessive velocity. In some countries the regulations stipulate that a double speed measuring system be used.

In prior art, a solution is known in which elevator speed is measured by means of a tachometer mounted on the shaft of the drive motor of the elevator and the speed data obtained via this measurement is compared with an allowed limit speed value. Because of the double measurement required, two separate tachometers are mounted on the motor shaft. The tachometer contains parts that are subject to wear and must be replaced in conjunction with maintenance. The interval between changes of carbon brushes may be as short as three months in the worst case. The wear of the tachometer drive belt causes an additional error, which needs to be repeatedly corrected during maintenance.

The object of the present invention is to develop a new solution for indicating elevator speed. To achieve this, the procedure of the invention is characterized by the features presented in the characterization part of claim 1. Correspondingly, the apparatus of the invention is characterized by the features presented in the characterization part of claim 6. The features characteristic of other preferred embodiments of the invention are defined in the sub-claims.

With the solution of the invention, reliable and accurate measurement of elevator speed data is achieved. The accuracy of the result is preserved substantially unchanged throughout the life span of the device and no latent error due to wear of the drive is generated because the measuring sensor remains apart from moving parts. The apparatus used in this solution does not contain any wearing parts like those comprised in a solution based on a normal tachometer, which means substantially less need for maintenance.

Redoubling of measurement data is implemented using two inductive proximity switches mounted beside the same wheel connected to the car. Each one of the switches is associated with a separate measurement channel and a separate power supply. The outputs of the measurement channels are connected via a contactor safety connection to the safety circuit.

The solution can be fitted in different elevators without any special operations. The only parameter to be changed is the limit speed value, which is selected by means of code switches. The modular structure of the solution allows the invention to be applied to fast elevators having several limit switches, in which the speed limits can be easily set by means of code switches. The range of components and the production costs are reduced because the components can be

manufactured in larger series.

In the following, the invention will be described in detail by the aid of an example embodiment by referring to the attached drawings, in which

- Fig. 1 presents a diagram representing the invention in an elevator environment,
- Fig. 2 presents an overspeed governor in conjunction with a solution according to the invention,
- Fig. 3 presents a speed signal indicating circuit,
- Fig. 4 illustrates the speed signal hysteresis,
- Fig. 5 presents a modulation system for the speed measurement.

Fig. 1 shows a diagrammatic view of an elevator shaft 2 with an elevator car 4 moving in the shaft, supported by suspension ropes. Mounted in the elevator car is a ramp 48, which opens limit switches 44 and 46 mounted in the upper and lower parts of the shaft. The suspension ropes, elevator machinery, other shaft equipment and the devices used in the elevator car and at the landings are conventional solutions known in elevator technology and are not comprised in the sphere of the present invention. They are therefore not shown in the figures. Mounted above the elevator shaft is an overspeed governor 6, which indicates the velocity of the elevator car and, in particular, outputs a triggering pulse to the safety gear when the velocity of the elevator car exceeds the maximum allowed limit value. Another rope, i.e an overspeed governor rope 8 is attached by one end to the top 10 of the elevator car, from where the rope 8 is passed over the drive wheel 12 of the overspeed governor and further around a diverting pulley 14 in the lower part of the elevator shaft 2 to the bottom 16 of the elevator car, to which the other end of the rope 8 is attached. The drive wheel of the overspeed governor thus

rotates at a speed proportional to the speed of the elevator car.

As can be seen from Fig. 2, the drive wheel 12 mounted on the overspeed governor shaft is provided with holes 20 placed at regular intervals at the same distance from the shaft. Alternatively, a separate disc with corresponding holes is mounted on the shaft of the overspeed governor. Fitted opposite to the holes 20, beside the wheel 12, are two inductive sensors 22 and 24, which produce pulses as the wheel rotates. The distance between the sensors preferably corresponds to the hole pitch or its multiple, so the pulses are in phase. The pulses from the inductive proximity sensors 22 and 24 are passed via conductors 23 and 25 to an ETS supervision circuit 21, to which the limit switches 44 and 46 are also connected. The outputs 27 and 29 of the ETS supervision circuit are part of the safety circuit of the elevator. The operation of the ETS circuit is described in greater detail in conjunction with Fig. 5.

Instead of a wheel with holes, it is possible to use a toothed wheel with an inductive sensor mounted near the teeth, in which case the sensor pulse length corresponds to the tooth width. A perforated or toothed disc can also be fitted directly onto the shaft of the elevator motor.

When the hole diameter is s_2 and the solid part between holes is s_1, the distance covered by a point on the circumference of the overspeed governor during a pulse and therefore the distance travelled by the elevator car connected to it via the rope 8 can be calculated as

$$s = \frac{d*\pi}{n} * \frac{s_1}{s_1 + s_2}, \text{ where}$$

d = drive wheel diameter

n = number of holes.

By calculating the time required for the elevator car to travel through distance s, the speed of the elevator can be obtained in a known manner. According to the invention, this is implemented by counting the number of clock pulses of an internal oscillator during each pulse produced by the inductive sensor. The clock pulses are applied to input 26 (Fig. 3) and the pulses of the sensor 22 are applied to input 28 and passed to an up-counter 30. The counter 30 triggers a latch 32 when the counter counts a pre-set number of pulses during the sensor pulse and the output 35 of the controller 34 is not reset during this time. If the counter cannot reach the pre-set pulse count, the latch will not be triggered and the resetting of the sensor output signal results in resetting the output 35 of the controller 34. In this situation, the output of the channel A associated with the sensor 22 indicates an overspeed, and this causes the safety circuit to be opened. Connected to the other sensor 24 is a corresponding circuit B, whose components are identified by reference numbers provided with an apostrophe, e.g. counter 30', latch 32' and so on.

By means of code switches 31 and 31' acting on the starting value of the counter, a correct initial counter value is selected for each elevator and its speed. In the example presented in Fig. 2, the code switches affect six bits in an eight-bit counter. The two lowest bits are reserved for an inter-channel measurement hysteresis function to be described later on.

To ensure that overspeed is indicated as simultaneously as possible on both channels, extreme installation accuracy is required in positioning the sensors. To alleviate the requirement of absolute precision, the measurement according to the present invention comprises a hysteresis that allows

a small difference between sensors and between channels. To achieve this, the output of the A-channel latch 32 together with the output of the B-channel latch 31' is applied to an OR circuit 36, whose output is used to correct the initial counter value by two bits. Thus, the triggering threshold is lowered accordingly and the output of the first channel follows the output of the second channel. The circuits of both channels are identical, so a pulse signal at the output of either channel results in a reduction of the limit value for both circuits. As the circuits are cross-connected in this respect, both channels must have separate indication of normal speed to allow the limit value level to be restored to its initial value.

The graph in Fig. 4 illustrates the action of the hysteresis comprised in the present invention as described above. Curve 40 represents the speed value measured by channel A, and, correspondingly, curve 42 represents the speed value measured by channel B. When curve 40 exceeds (at instant t_1) the actual overspeed limit ON, the output of channel A is reset. At the same time, the speed limit is lowered to the value OFF, and when curve 42 is above this OFF value, the output of channel B is also reset. At instant t_2, curve 42 goes below the OFF limit value, channel A outputs a signal and at the same time the limit value is restored to the ON level because the OR-circuit outputs 36 and 36' are reset at the same time.

The signals 35 and 35' obtained from the overspeed monitoring circuit 51 (Fig. 5) presented in Fig. 3 are used to control a contactor circuit 53 designed to ensure that the safety circuit is broken each time an overspeed is detected in either channel. The output 35 of speed measuring channel A controls triac 50 in the contactor circuit, which switches a voltage to coil 54 via auxiliary contacts 58A

and 58C. In a corresponding manner, the output 35′ of measuring channel B controls triac 52, which switches a voltage to coil 56 via auxiliary contacts 60A, 64B and 64C. Coil 62 is controlled by auxiliary contacts 64A, 64B and 64C. Coils 54, 56 and 62 control contactors 66, 68 and 70, which are part of the safety circuit and connected via conductors 37 and 39 to the rest of the safety circuit. With this contactor circuit, the safety circuit is closed when the speed is below the overspeed limit. When either one of the measuring channels indicates an overspeed, the corresponding contactor in the contactor circuit is opened, thus breaking the safety circuit.

Together with the mechanical limit switches, the signals of the overspeed monitoring circuit form part of the safety circuit. As mentioned in connection with Fig. 1, the limit switches 44 and 46 are placed in the elevator shaft near the terminal floors, i.e. near the topmost and bottommost floors, so that the ramp 48 mounted on the elevator car 4 will open the switches when it touches them. When the speed of the elevator is above 3.2 m/s, a second pair of limit switches 76 and 78 are needed, and when the speed is over 4.0 m/s, a third pair of limit switches 80 and 82 are needed, and when the speed is over 5.2 m/s, a fourth pair of limit switches 84 and 86 are needed. For each limit switch, a separate module 61, 71 and 81 is installed, each module comprising a speed monitoring circuit and a contactor circuit, with the signal obtained from an inductive sensor connected to the signal inputs of the modules. The positions of the limit switches in the elevator shaft are determined in accordance with the speed levels, and so are the overspeed limits for each elevator and for each switch. The limit values corresponding to different speed levels are set via code switches for each module. When a speed supervision circuit as provided by the invention is being in-

stalled in fast elevators, a new module is added for each speed level and the corresponding limit switch. The safety circuit is opened when the speed limit for any speed level is exceeded.

In the foregoing, the invention has been described by the aid of some of its embodiments. However, the description is not to be regarded as constituting a limitation of the scope of patent protection, but the embodiments of the invention may vary freely within the limits defined by the following claims.

CLAIMS

1. Procedure for indicating speed of a traction sheave elevator wherein the elevator car is suspended by suspension ropes, in which procedure the velocity of a wheel (12) connected to the elevator car (4) by means of another rope (8) so that the velocity of the wheel is proportional to the velocity of the car (4), in which procedure the velocity is compared with a reference value and an indication is given when the velocity exceeds the reference value, **characterized** in that the wheel (12) is provided with one or more sensors (s_1) and a detector (22,24) is placed near the wheel to detect the sensors (s_2), that the time required for successive sensors (s_1) to pass the detector (22,24) is computed, that the computed time is compared with a reference time corresponding to a reference speed and that when the computed time is below the reference time, an overspeed is identified.

2. Procedure as defined in claim 1, **characterized** in that the wheel (12) is provided with two detectors (22,24) and an overspeed is identified when at least one of the detectors (22,24) indicates that the time interval between successive sensors (s_1) is below the reference time.

3. Procedure as defined in claim 2, **characterized** in that when one detector indicates a time interval below the reference time, the reference time for the other detector (22,24) is increased.

4. Procedure as defined in any one of the preceding claims 1 - 3, **characterized** in that the time required for the sensors (s_1) to pass the detectors is measured by counting the number of pulses of an internal oscillator when a sensor (s_1) is passing.

5. Procedure as defined in any one of the preceding claims 1 - 4, **characterized** in that the time required for the sensor to pass the detector (22,24) is determined.

6. Apparatus for indicating speed of a traction sheave elevator wherein the elevator car is suspended by suspension ropes, comprising a wheel (12) connected to the car (4) via another rope (8) so that the speed of the wheel (12) is proportional to the speed of the car (4), said apparatus further comprising a comparing element (A,B;51) for comparing the speed with a reference value, the output of said comparing element (A,B;51) giving an indication when the speed exceeds the reference value, **characterized** in that the wheel (12) is provided with one or more sensors (s_1) and that a detector (22,24) for detecting the sensors (s_1) is provided near the wheel (12), that the apparatus comprises an oscillator (26) for generating pulses and a counter (30) for counting the oscillator pulses generated during the time between successive sensors (s_1), said comparing element (A,B;51) indicating an overspeed when the number of oscillator pulses is below the reference value.

7. Apparatus as defined in claim 6, **characterized** in that it comprises two detectors (22,24) disposed in the path of the sensors (s_1) on the circumference of the wheel (12), and a separate counter (30,30') and comparing element (26,26') is provided for each detector.

8. Apparatus as defined in claim 7, **characterized** in that the apparatus comprises a regulating element (31) for adjusting the reference value, which regulating element alters the reference value for the other circuit (A,B) when one circuit (B,A) indicates an overspeed.

9. Apparatus as defined in any one of claims 6 - 8, **characterized** in that the sensors are placed in an overspeed gov-

ernor (6) provided with a toothed disc.

10. Apparatus as defined in any one of claims 6 – 8, **characterized** in that the sensors (s_1) consist of the solid parts between holes (20) in a perforated disc.

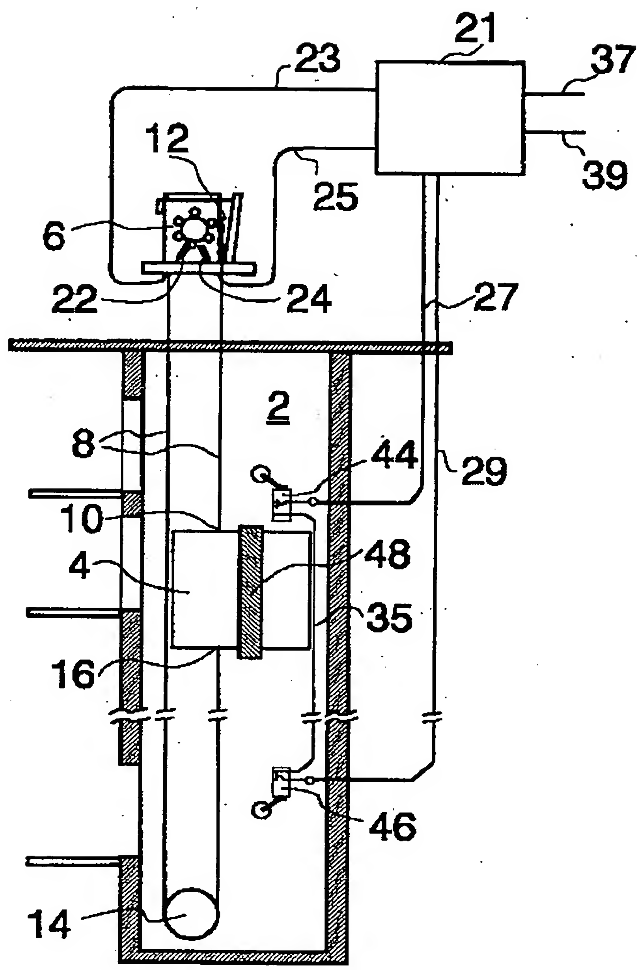


Fig. 1

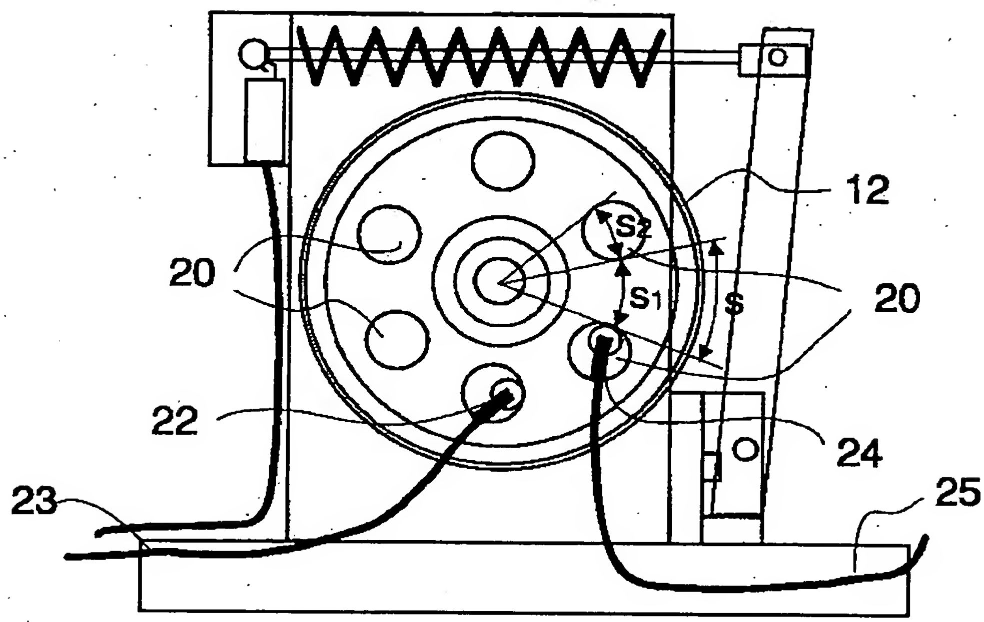

12
S2
20
S1
S
20
22
24
23
25

Fig. 2

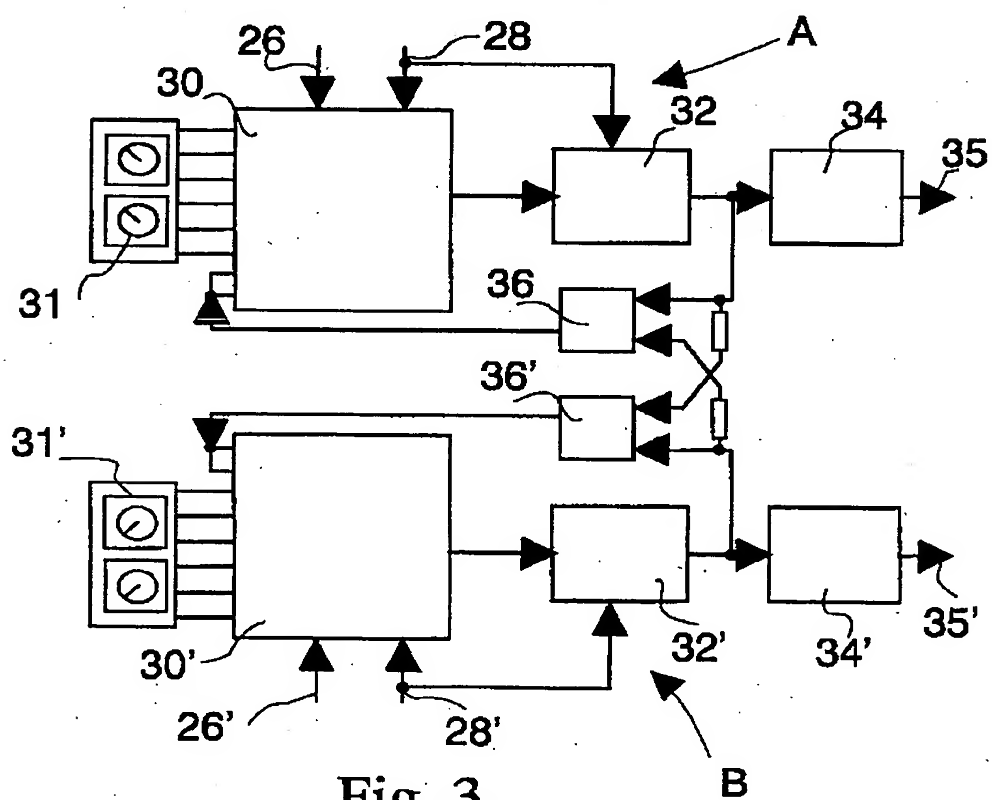

26
28
A
30
32
34
35
31
36
36'
31'
30'
32'
34'
35'
26'
28'
B

Fig. 3

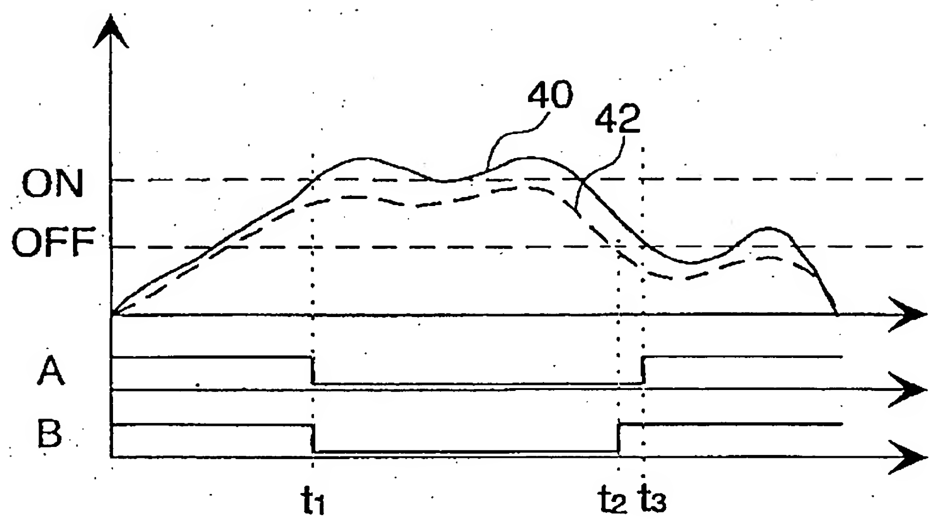
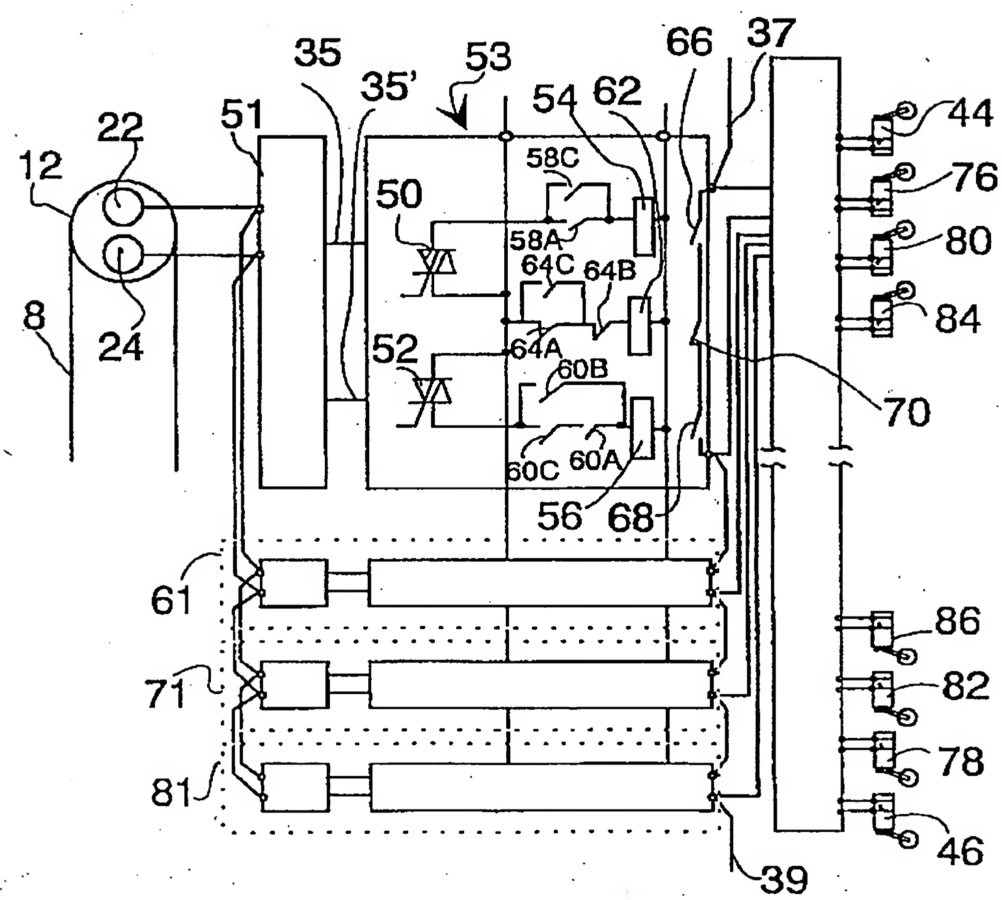

40
42
ON
OFF
A
B
t1
t2 t3

Fig. 4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35'
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66
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54
62
51
22
12
50
58C
58A
64C
64B
44
76
80
84
8
24
52
64A
60B
70
60C
60A
56
68
61
71
81
86
82
78
46
39

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00638

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B66B 5/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 405999 A2 (OTIS ELEVATOR COMPANY), 2 January 1991 (02.01.91), column 3, line 39 - line 46; column 4, line 7 - line 36; column 7, line 40 - line 58, column 9, line 26 - line 33; column 14, line 19 - line 28; column 15, line 1 - line 33; abstract, figures 1-7 --	1-8
X	US 4503939 A (F.L. LAWRENCE ET AL.), 12 March 1985 (12.03.85), column 1, line 53 - column 2, line 22; column 2, line 61 - line 65; column 3, line 15 - line 28, column 4, line 13 - column 5, line 25, abstract; figure 1 --	1,4-6,9-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 March 1998	23 -03- 1998
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00638

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5458216 A1 (M. TANAKA ET AL.), 17 October 1995 (17.10.95), column 5, line 11 - line 34, figure 1, abstract	1-10

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI 97/00638

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 405999 A2	02/01/91	NONE	
US 4503939 A	12/03/85	AU 575064 B	21/07/88
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		JP 60102380 A	06/06/85
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		JP 6144734 A	24/05/94